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SUPPLEMENTARY EXAMINATION (2023-24)

CLASS - XI (PHYSICS)

TIME: 3 Hrs **Max.Marks: 70**

Instructions:

i) The Question paper has five sections: Section A, Section B, Section C, Section D and Section E. All the sections are compulsory.
ii) Section A has sixteen questions 12 MCQ and 4 Assertion-Reason questions of 1 mark each.
iii) Section B contains five questions of two marks each.
iv) Section C contains seven questions of three marks each.
v) Section D contains two case study-based questions of 4 marks each.
vi) Section E contains three long questions of five marks each.
vii) There is no overall choice. However, an internal choice has been provided in 1 question in section B, 1 question in section C, 1 question in each case Based question in section D and in all 3 questions of section E. You have to attempt only one of the choices in such questions.

SECTION-A

1. The pair of the quantities having same dimensions is
(a) Displacement, velocity
(b) Time, frequency
(c) Wavelength, focal length
(d) Force, acceleration

2. Which of the following can be zero, when a particle is in motion for some time?
(a) Displacement
(b) Average Speed
(c) Distance
(d) None of these

3. A body of mass 2 kg moves with an acceleration of 3 m s^{-2}. The change in momentum in one second is
(a) 6 kg m/s
(b) 2/3 kg m/s
(c) 3/2 kg m/s
(d) zero

4. A body of mass 10 kg is travelling with uniform speed of 5 m/s. Its kinetic energy is:

(a) 25 J
(b) 125 J
(c) 1250 J
(d) 1000 J

5. When the torque acting on the system is zero, which of the following is constant?
(a) Linear impulse
(b) Linear momentum
(c) Force
(d) Angular momentum

6. The value of acceleration due to gravity on Earth would be high if Earth's
(a) mass and radius both are small
(b) mass is small and radius is large
(c) mass is large and radius is small
(d) mass and radius both are large.

7. The forces responsible for a body regaining its shape after removal of deforming forces are _____
(a) gravitational forces between atoms
(b) electromagnetic forces between atoms
(c) nuclear forces within an atom
(d) combination of gravitational & nuclear forces between atoms

8. In case of fluid dynamics equation of continuity is based on the:
(a) Work energy theorem
(b) Law of conservation of energy
(c) Conservation of mass
(d) Conservation of momentum

9. What is the relation between coefficient of area expansion(A) and coefficient of volume expansion(B)?
(a) B = 1.5A
(b) A = 1.5B
(c) A = 3B
(d) B = 3A

10. If 315 cal of heat is given to the system, and the system does 20cal of work, find the change in internal energy.
(a) 295 cal
(b) 335 cal
(c) 0 cal
(d) 335 J

11. First law of thermodynamics is based on:
(a) Conservation of linear momentum

(b) Conservation of energy
(c) Conservation of angular momentum
(d) Conservation of mass in fluid dynamics

12. There is an increase in temperature of an ideal gas then the kinetic energy of the ideal gas _____
(a) decreases
(b) increases
(c) remains the same
(d) it is not related to the temperature

Two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to questions 13 to 16 from the codes (a), (b), (c) and (d) as given below.
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true and R is NOT the correct explanation of A
(c) A is true and R is false
(d) A is false and R is also false

13. **Assertion:** The dot product of one vector with another vector may be a scalar or a vector.
Reason: If the product of two vectors is a vector quantity, then product is called a dot product.

14. **Assertion:** Work done against the gravity is independent of path.
Reason: Gravitational force is a conservative force.

15. **Assertion: Gravitational potential of earth at every place on it's surface is negative.**
Reason: Everybody on earth is bound by the attraction of earth i.e. Gravitational force is always attractive force.

16. **Assertion:** Zeroth law of thermodynamics gives us the concept of temperature.

Reason: Internal energy of an ideal gas does not depend upon temperature.

SECTION-B

17. A calorie is a unit of heat or energy and it equals about 4.2 J where 1 J = 1 kg m^2 s^{-2}. Suppose we employ a system of units in which the unit of mass equals α kg, the unit of length equals β m, the. unit of time is γ s. Show that a calorie has a magnitude 4.2 $\alpha^{-1}\beta^{-2}\gamma^2$ in terms of the new units.

18. Derive an expression for distance travelled during the nth second of motion in case of one dimensional uniform accelerated motion.

OR

Displacement of a particle is given by the expression $x = 3t^2 + 7t – 9$, where x is in metre and t is in s. Calculate velocity and acceleration at t= 1 s.

19. State (i) law of orbits and (ii) law of areas for planetary motion.

20. Prove that the elastic potential energy per unit Volume in a stretched wire is equal to ½ x Stress x Strain.

21. The frequency of the third harmonic of a closed organ pipe is same as that of second harmonic of an open organ pipe. Calculate the ratio of lengths of their air column.

SECTION-C

22. (a) A cricketer can throw a ball to a maximum horizontal distance of 100 m. How much high above the ground can the cricketer throw the same ball?

(b) Read the following statement carefully and state, with reason and example , if it is true or false: " A scalar quantity is one that can never take a negative value"

23. (a)A shell of mass 20g is fired by a gun of mass 100kg. If the muzzle speed of the shell is 80 m/s, what is the recoil speed of the gun?
(b) Explain why a cricketer moves his hands backwards while holding a catch.

OR

(a)A nucleus is at rest in the laboratory frame of reference. Show that if it disintegrates into two smaller nuclei, the products must be emitted in opposite directions.
(b) Explain why passengers are thrown forward from their seats when a speeding bus stops suddenly.

24. Obtain an expression for potential energy of an elastic spring and also draw the graph of potential energy vs displacement.

25. (a) State and explain the law of conservation of angular momentum.

(b) Write the expression for moment of inertia of a circular disc of mas M and diameter R about its diameter.

26. (i) State Wien's displacement law.
(ii) Light from the moon, is found to have a peak (or wavelength of maximum emission) at λ=14 μm. Given that the Wien's constant b equals 2.9×10^{-3} m K, estimate the temperature of the moon.

27. Using assumptions of kinetic theory of gases derive the expression for the pressure exerted by an ideal gas and establish its relation with kinetic energy of the gas.

28. Obtain the expression for total energy of a particle executing Simple harmonic motion (SHM). Show graphically the variation of potential energy (P.E.) and kinetic energy (K.E.) with displacement in SHM.

SECTION-D

Read the following passage and choose appropriate answers of questions 29 to 30.

29. When an object follows a circular path at a constant speed, the motion of the object is called uniform circular motion. The word “uniform” refers to the speed, which is uniform (constant) throughout the motion. Suppose an object is moving with uniform speed v in a circle of radius R Since the velocity of the object is changing continuously in direction, the object undergoes acceleration. Let us find the magnitude and the direction of this acceleration. Thus, the acceleration of an object moving with speed v in a circle of radius R has a magnitude v^2/R and is always directed towards the centre. This is why this acceleration is called centripetal acceleration (a term proposed by Newton).

(i) In uniform circular motion

(a) Speed remains constant

(b) Magnitude of velocity remains constant

(c) Magnitude of acceleration remains constant

(d) All of the above .

(ii) A centripetal acceleration is not a constant vector. True or false?

(a) True

(b) False

(iii) Write the expression for centripetal force.

(iv) Centripetal acceleration can be mathematically expressed as

(a) $a_c = \omega^2/R$

(b) $a_c = \omega/R^2$

(c) $a_c = R^2$

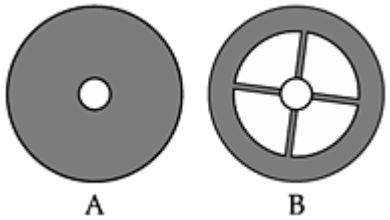
(d) $a_c = \omega^2 R$

OR

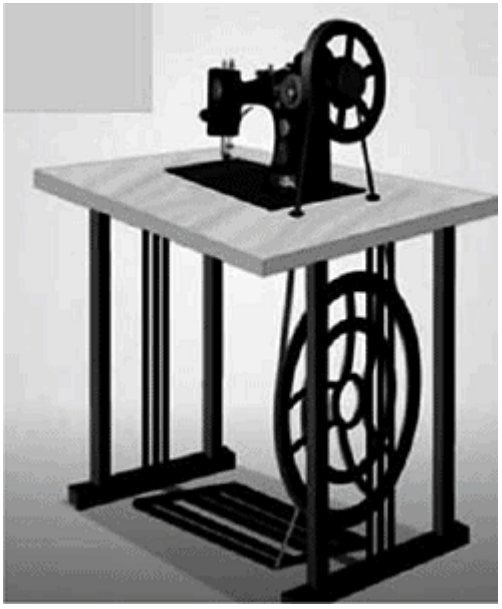
If both speed of a body and radius of the circular path are doubled, what will be the change in centripetal force?

30. Flywheel and sewing machine

There is a difference between inertia and moment of inertia of a body. Inertia depends on the mass of the body but the moment of inertia about an axis depends on the mass of the body and the distribution of its mass about the axis. In the following figure, the masses of the two wheels are exactly equal but in the wheel (A) the mass is uniformly distributed and in the wheel (B) most of the mass is situated at the rim. Both the wheels rotate about axis passing through the centre. It is noticed that while the two wheel are set in rotation and left, wheel (B) continues rotating for a longer time.



This means that the moment of inertia of wheel (B) is greater than the wheel (A). Also greater is the part of the mass of the body away from the axis of rotation, greater the moment of inertia of the body about the axis. Such a wheel is known as flywheel. Consider a foot operated sewing machine. It has of two wheels – one big and the other small. The wheels are connected by a rope. The bigger wheel acts as flywheel. The rope transfers the motion from this flywheel to the smaller wheel. Smaller wheel works as a pulley and also as a small flywheel.



We see even we stop supply of driving force to the bigger wheel it still continues to run for a short time because of its moment of inertia. So, flywheel acts as an energy reservoir by storing and supplying mechanical energy when required. The kinetic energy stored in a flywheel is

$$E = \frac{1}{2} I\omega^2$$

(where I = moment of inertia and ω = angular velocity).

(i) Which of the following statement is true?

(a) Moment of inertia depends on the total mass and the distribution of mass from the axis of rotation.

(b) Inertia depends on the total mass and the distribution of mass from the axis of rotation.

(c) If the masses of two objects are equal then their moment of inertia are also equal.

(d) As mass of an object is distributed away from the axis of rotation, the moment of inertia decreases.

(ii) What do you mean by the term “Flywheel” ?

(iii) We see even we stop supply of driving force to the bigger wheel of foot operated sewing machine, it still continues to run for a short time. If the rim of this wheel is made thicker then

(a) It will run for the same period when the driving force is stopped.

(b) It will run for shorter period when the driving force is stopped

(c) It will run for longer period when the driving force is stopped.

(d) It will stop immediately when the driving force is stopped.

(iv) Energy stored in a flywheel depends upon

(a) moment of inertia of flywheel

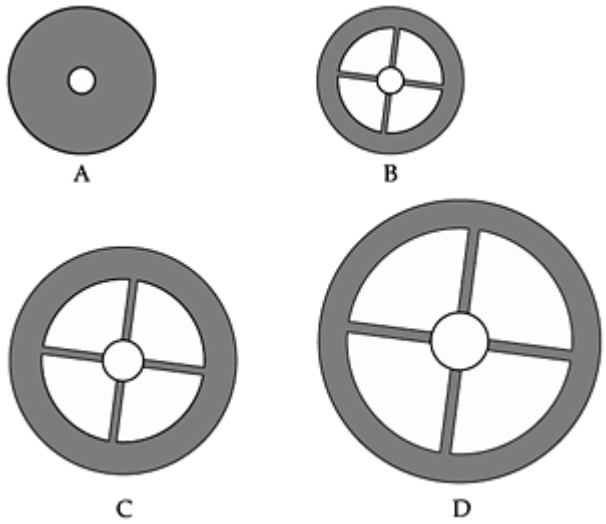
(b) angular velocity and moment of inertia of flywheel

(c) angular velocity of flywheel

(d) none of the above

OR

Which one of the following wheel (having same mass) will have highest moment of inertia about axis passing through the centre**?**



(a) Wheel A

(b) Wheel B

(c) Wheel C

(d) Wheel D

SECTION-E

31. (i) Explain the terms impulse and impulsive force .

(ii) A batsman hits a ball straight in the direction of the bowler without changing its initial speed of 12 m s^{-1}. If the mass of the ball is 0.15 kg, determine the impulse imparted to the ball. (Assume linear motion of the ball)

(iii)Give the magnitude and direction of the net force acting on a stone of mass 0.1 kg, just after it is dropped from the window of a train accelerating with 1 ms^{-2}.

OR

(i) Establish the relation between coefficient of friction and angle of friction.

(ii) Determine the maximum acceleration of the train in which a box lying on its floor will remain stationary. Given that the co – efficient of static friction between the box and the train's floor is 0.15.

(iii) Give the magnitude and direction of the net force acting on a kite skillfully held stationary in the sky.

32. (i) State Stoke's law and use it to derive the expression for terminal velocity of a spherical body falling in a uniform viscous medium.
(ii) If eight rain drops each of radius 1mm are falling through air at a terminal velocity of 5 cm/s. If they coalesce to form a bigger drop, what is the terminal velocity of bigger drop?

OR

(i) Write the statement of Bernoulli's theorem? Show that the sum of pressure, potential and kinetic energy per unit volume in the streamline flow of an ideal fluid is constant.
(ii) Explain why a drop of liquid under no external force is always spherical in shape.

33. (i) Use the following formula to explain why speed of sound in an ideal gas

$$v = \sqrt{\frac{\gamma P}{\rho}}$$

(a) is independent of pressure,

(b) increases with temperature,

(c) Increases with humidity.
Here, v = speed of sound, P= pressure ,ρ = density and γ = ratio of specific heats

(ii) Write Newton's formula for speed of longitudinal wave in an ideal gas /air and explain Laplace correction.

OR

A transverse harmonic wave on a string is described by

$$y(x,t) = 3.0 \sin\left(36t + 0.018x + \frac{\pi}{4}\right)$$ ……..(i)

Where x and y are in cm and t in s. The positive direction of x is from left to right.

(a) Is this a travelling wave or a stationary wave?

If it is travelling, what are the speed and direction of its propagation?

(b) Calculate its amplitude and frequency?

(c) Calculate the initial phase at the origin?

(d) Calculate the least distance between two successive crests in the wave?